



**TECHNICAL
PUBLICATION**

**NATIONAL PHOTOGRAPHIC
INTERPRETATION CENTER**

TEST AND EVALUATION REPORT



25X1

**VIEWING PORTS IN STEREO RHOMBOID OBJECTIVES
FOR THE ZOOM 240 SYSTEM**

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DECLASS REVIEW BY NIMA / DoD

NPIC/R-13/73

MAY 1973

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Comments and queries regarding this report are welcomed.



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CONTENTS

| | Page |
|--|------|
| ABSTRACT | iii |
| 1. INTRODUCTION | 1 |
| 2. SUMMARY OF TEST RESULTS | 2 |
| 3. CONCLUSIONS AND RECOMMENDATIONS | 3 |
| 4. DESCRIPTION OF EQUIPMENT | 5 |
| 5. TEST DETAILS | 6 |
| 5.1 Acceptance Tests | 6 |
| 5.2 Engineering Evaluation | 8 |
| 5.3 Operational Evaluations | 10 |
| FIGURE 1 | iv |
| FIGURE 2 | 4 |

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ABSTRACT

The Stereo Rhomboid Objectives (also called the stereo lens assemblies) with viewing ports were tested and evaluated at NPIC between September 1972 and April 1973. Acceptance tests, engineering evaluation, and operational evaluations were conducted within this time period.

Both the 1X and 2X magnification versions are well constructed. They essentially met all of the contractual requirements. It is recommended that parallax between the viewfinder alignment dot and imagery be overcome before this concept is implemented further.

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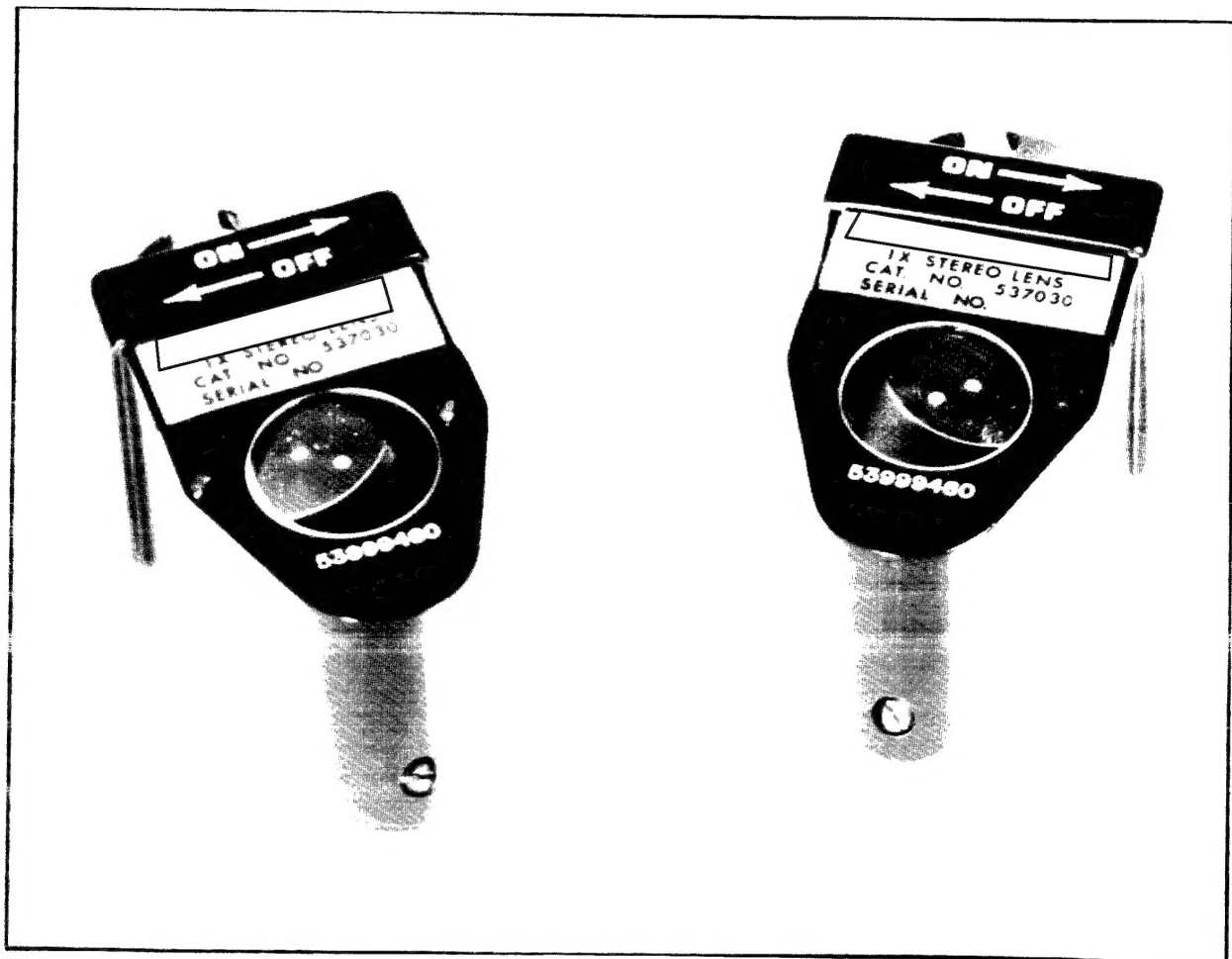


Figure 1 - ☐ 1X Stereo Rhomboid Objective Set with Viewing Ports

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☐ VIEWING PORTS IN STEREO RHOMBOID OBJECTIVES
FOR THE ZOOM 240 SYSTEM

1. INTRODUCTION

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These ☐ stereo rhomboid objectives have viewing ports, Figure 1, to allow the PI to see the film imagery directly as well as through the eyepieces of the Zoom 240. The purpose is to get stereo fusion more quickly. The objectives were received by TEB on 29 September 1972 in partial fulfillment of RED's Zoom 240 Improvements contract with ☐. The other item, a rear projection viewer, produced under this contract is reported on in T&E report NPIC/R-12/73, dated May 1973.

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This report covers the two pairs of objectives with nominal magnifications of 1X and 2X. They fit on the stereo rhomboid arms ☐, replacing the nonviewing port objectives of the Zoom 240 Stereoscope. When a PI looks vertically down at the film on the light table through a viewing port, he is actually looking through a beam splitter that directs most of the light into the optics of the Zoom 240.

This report contains acceptance test results, engineering evaluation results, and a summary of operational evaluation reports from two operating components in ☐.

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2.. SUMMARY OF TEST RESULTS

2.1 Acceptance tests for contractual compliance included measurements of light transmission, optical resolution, and optical magnification. There was also a requirement for compatibility with the Zoom 240 system and the basic requirement to permit viewing imagery located directly beneath the rhomboid objectives. Both the 1X pair and 2X pair of viewing port objectives successfully met all contractual requirements except for one special case, human factors constraint.

2.2 An engineering evaluation concluded that the units are well constructed, both mechanically and optically. It was noted that a tilting light table is needed in order to utilize the viewing port feature whenever a rhomboid is rotated toward the rear of the light table. It was also noted that for persons unable to use either eye at will, the usefulness will be limited when one rhomboid arm is rotated back alongside the Zoom 240 pod.

2.3 Two operating components in [] conducted an operational evaluation and provided written reports summarizing their findings. The Imagery Exploitation Group reported that all of the PIs involved acquired stereo fusion 25 to 50 percent faster when using the viewing ports. This component found an additional benefit in that they enable PIs to locate a feature on a map without removing that feature from stereo.

25X1

The second operating component reported a generally negative reaction. Most of their participating PIs did not find it quicker to acquire stereo by means of the viewing ports.

Both components found that the single aligning dot creates a parallax problem which needs correcting prior to serious consideration for additional procurement.

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NPIC/R-13-73

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 The Test and Evaluation Branch concludes that the prototype objectives with viewing ports do have the potential to realize their basic purpose of making it possible for many users to acquire stereo fusion more quickly.

3.2 However, several optical parameters need to be seriously considered before production procurement is initiated. The contractually specified beamsplitter ratio of 20 to 1 (reflectance to transmittance) decreases the transmitted light through the microscope only 5 percent; but with the trend to higher magnifications requiring more light, this light loss must be considered. Another conclusion is that the 20 to 1 beamsplitter ratio specification needs a tolerance value to prevent a recurrence of great differences such as occurred on the prototype units (25:1 to 12:1). The final conclusion reached is that the parallax which bothered many potential users should be eliminated, or at least reduced, in order to make the device useful to a greater number of operators.

3.3 It is recommended that the following steps be taken prior to production procurement:

- o Modify and test one each of the existing 1X and 2X objectives, or produce an additional pair, to eliminate or reduce the offending parallax.
- o Include an appropriate beamsplitter ratio tolerance in the procurement specification.
- o Consider the effect of the 5 percent light loss on future operations when deciding on the quantity to be procured.

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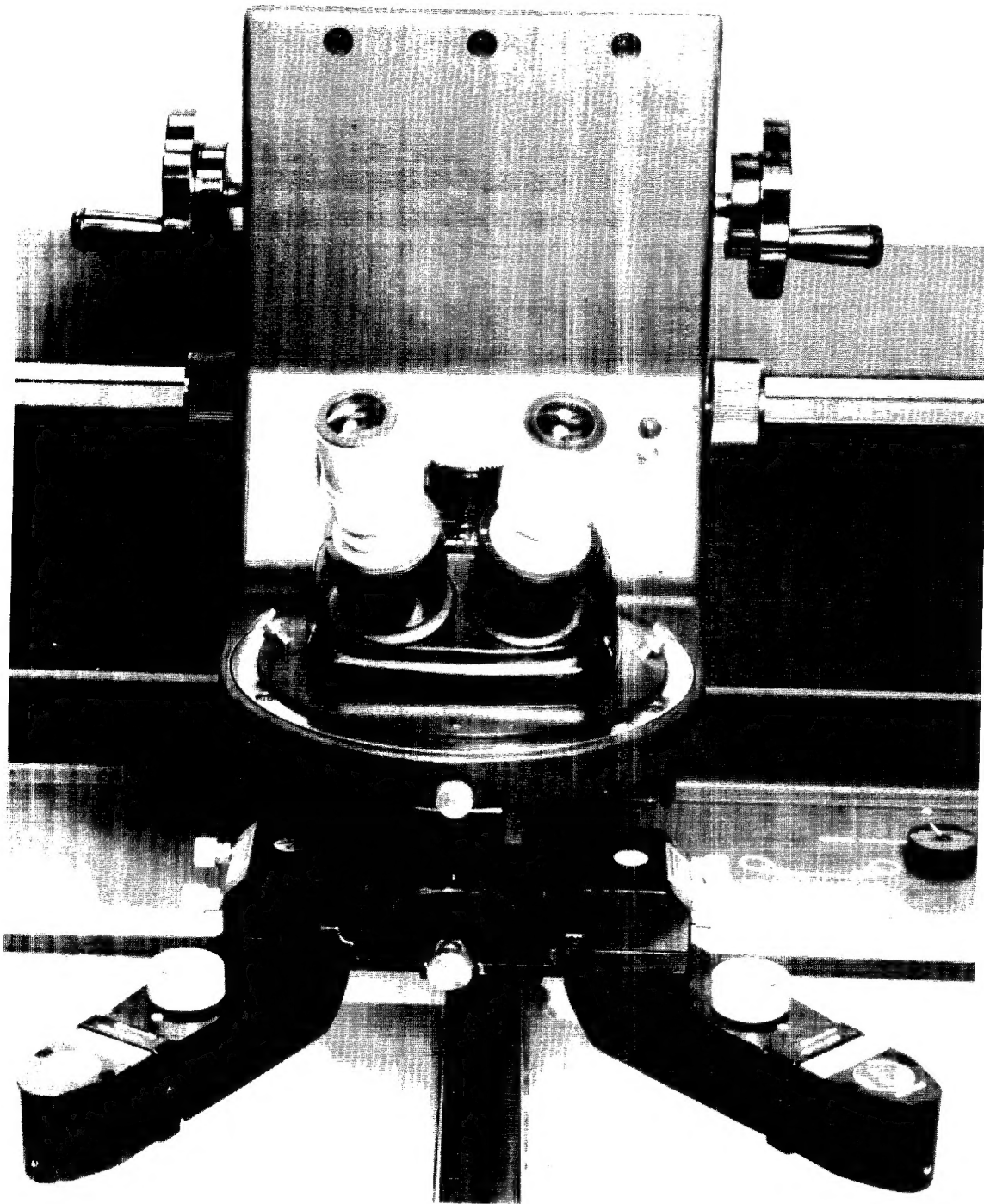


Figure 2 - ☐ LX Stereo Rhomboid Objectives with Viewing
Ports Mounted on a Zoom 240 System

4. DESCRIPTION OF EQUIPMENT

The two sets of stereo rhomboid objectives with nominal magnifications of 1X and 2X are provided with one-quarter turn locking flanges. The 1X set is shown in Figures 1 and 2. The locking flanges allow the objectives to replace the stereo lenses on the stereo rhomboid arms of the Zoom 240 Stereoscope System. Figure 1 shows a white reference dot in the center of each viewing port window (a reflection of it in the beamsplitter also shows). The dot is intended to aid the PI in placing the optical axis over the desired area of the imagery. The imagery is visible through the viewing port window and an internal beamsplitter. In the case of the 2X objectives, the PI will be viewing the imagery through a lens element as well. The 1X objectives contain no lenses. The beamsplitter that allows the PI to view the imagery through the port directs most of the light into the optics of the Zoom 240. Thus, the Zoom 240 system can be used normally. 25X1

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5. TEST DETAILS

5.1 Acceptance Tests

Light Transmission

The reduction in light transmission is to be less than 50 percent.

Test Method - The light table (1540) was allowed to stabilize at maximum intensity. The relative light level from each assembly (old and new) was measured through the 10X W.F. eyepiece of the Zoom 240. The measurements were made with a Gamma Model 2020 photometer using a photopic filter and the general cosine head at the plane of the exit pupil of the Zoom 240 eyepiece.

25X1

Another set of measurements was made through the viewing ports with a Spectra Spot Brightness meter. A +3 diopter lens was needed to allow the Spectra to focus at a near distance.

Test Results -

The reduction of light transmission relative to the stereo lens assemblies without viewing ports was:

| | |
|---------------|------------|
| 1X S/N 3494LF | 16 percent |
| S/N 213WF | 10 percent |
| 2X S/N None | 13 percent |
| S/N None | 9 percent |

The apparent transmission through the viewing ports was approximately:

| | |
|---------------|-----------|
| 1X S/N 3494LF | 8 percent |
| S/N 213WF | 5 percent |
| 2X S/N None | 5 percent |
| S/N None | 4 percent |

It should be noted that the 2X assemblies have a lens below the viewing port and beamsplitter.

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Conclusion - The stereo lens assemblies not only satisfy but greatly exceed this requirement.

Optical Resolution

There is to be no degradation.

Test Method - Observe high contrast USAF 1951 pattern resolution targets TEB#28 (positive polarity) and TEB#36 (negative polarity). Move the stereo rhomboid arms to scan the resolution targets to off-axis as well as on-axis positions. Compare the resolutions with the standard stereo lens assemblies.

Conclusions - The optical resolution of the stereo lens assemblies with viewing ports is as good as or slightly exceeds that of the standard stereo lens assemblies. They meet this requirement.

Optical Magnification

The two sets of stereo lens assemblies are to provide 1X and 2X magnification respectively.

Test Method - Use an eyepiece with a reticle (TEB's Centering Eyepiece) and a millimeter scale (Maxta by Graticules Ltd. 0.01 mm increments) on the light tables. Optically superimpose the two scales to get the system magnification up to the eyepieces.

Test Result - The magnifications, within a few percent, are identical to those of the old 1X and 2X stereo lens assemblies without viewing ports. In addition, the 1X assemblies have no actual lenses in them so they must necessarily have unit magnification.

Conclusion - They meet this requirement.

Compatibility with Zoom 240

The stereo lens assemblies are not to degrade the performance of the Zoom 240 in any respect other than light transmission.

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Test Method - Compare the old and new assemblies for optical distortion, stereo fusion, parfocality, etc.

Test Results - The old and new assemblies are so similar that stereo fusion can be acquired when they are mixed (i.e., a new assembly on the left rhomboid and an old assembly on the right). A slight adjustment of the focus on each rhomboid arm is all that is required.

The mounting and demounting of the assemblies is accomplished with equal ease.

Conclusion - They meet this requirement.

Human Factor Constraint

The viewing ports shall enable a seated operator to observe the imagery located directly beneath the rhomboid objectives.

Test Results - A seated PI can see the imagery through the viewing port with one eye when the light table height is adjusted for viewing through the Zoom 240 eyepieces and the rhomboid arms are toward the front of the table. When one of the arms is toward the rear of the table (as it would be for dual web photography), the light table must be tilted a fair amount for a seated PI to be able to use the viewing port. However, for a PI who is not able to use either eye at will, he or she will be limited as to how far back alongside the Zoom 240 pod one of the arms can be rotated. It was noted that the protruding handle on the coarse focus of the microscope carriage sometimes directly interferes with the desired head position. And the focus positions for the 1X and 2X stereo lens assemblies are quite different so that the handle position changes drastically.

Conclusion - The stereo lens assemblies partially meet this requirement. Custom tailored procedures for the left-eyed and right-eyed PIs would make them effectively meet this requirement.

5.2 Engineering Evaluation

Construction

The stereo lens assemblies and their viewing ports are well constructed, both mechanically and optically.

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Viewfinder Dot

A 1.5 mm white spot is in the center of each viewing port window. They act as one part of a sight for aligning the desired portion of the imagery with the field of view of the stereo lens assembly. The second part of such a sight can be either the field of view of the stereo lens assembly or placement of the eye(s) on the vertical through the white spot using peripheral visual cues. Neither of these methods enables very precise positioning of the desired imagery under the rhomboid arms. However, it will be in the near vicinity so that the two arms can be nudged to the correct positions while looking through the eyepieces at the low zoom setting.

Beamsplitter Ratio

The stereo lens assemblies have beamsplitting mirrors to allow some of the image forming light to pass through to the viewing ports. The work statement in the contract referred to a partially transmitting mirror with a 1.3 neutral density coating. (This coating is the beamsplitting surface.) Such a coating would transmit one-twentieth of the incident light. Assuming no losses, the beamsplitter ratio (reflected light/transmitted light) would be 20 to 1. The beamsplitter ratios for the two 1X assemblies were 12 to 1 and 25 to 1 when measured with the Spectra Spot Brightness meter and an AIL light table. These values correlate closely with the transmission values reported in Section 5.1.

Light Transmission

Visually the image brightness at the eyepiece seemed adequate even with low contrast imagery of high average density (about 1.7) on a light table producing only about 1850 fL. Under the same conditions the image brightness through the viewing ports seemed inadequate. For more typical imagery, the stereo lens assemblies were quite satisfactory. One of the 1X assemblies, Serial Number 3494LF, appeared more nearly adequate than the others because it transmitted almost twice as much light through its viewing port (see Section 5.1).

Human Factors

The problem of left-eyed and right-eyed PIs, among others, was covered in the test results of Section 5.1 under Human Factor Constraint.

It was found that in using the viewing ports of the 2X objectives, the imagery appears to be below the plane of the light table surface. This is due (as noted in Sections 4 and 5.1) to a lens element located between the viewing port window and the film plane. As soon as the observer learns to accommodate for the effect, it causes no difficulty.

5.3 Operational Evaluations

The Imagery Exploitation Group found the viewing port feature to be extremely useful because it enabled them to locate a target on a map without removing the target from stereo. Their PIs did notice a parallax problem in the fine positioning of the objectives with the alignment dot. This, they feel can be corrected with the addition of a second alignment dot (or crosshair) at a different height above the focal plane. Despite the parallax, this component estimated that use of the viewing port feature enabled their PIs to acquire stereo fusion 25 to 50 percent faster than without.

Another operating component voiced a generally negative reaction. The extreme parallax thwarted the quick achievement of stereo. Most of their PIs felt that stereo can be more quickly and reliably obtained through normal methods unless the parallax problem is overcome.

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